New Mexico Institute of Mining & Technology

# Surface-Altered Zeolites as a Permeable Barrier

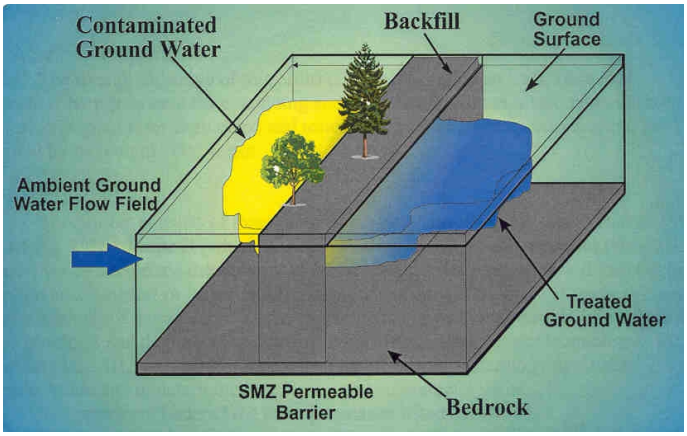
## Technology Need:

Contamination of shallow groundwater by organic and inorganic pollutants is common at many Department of Energy (DOE) and industrial facilities. Often it isn't the level of contamination, but the volume of groundwater contaminated, which dictates the ultimate cost of groundwater cleanup. Any technology which can retard the migration of pollutants while remediation solutions are designed and implemented will be valuable. Impermeable slurry walls (composed, for example, of bentonite mixtures) attempt to prevent the bulk movement of contaminated groundwater. Due to the resulting hydraulic gradients, such underground dams often fail due to groundwater movement over, under, or around the barrier. A cost-effective in situ water treatment technology is needed to meet this need.

## Technology Description:

New Mexico Institute of Mining and Technology (NMT) has developed a permeable barrier of surfactant modified zeolite (SMZ) which is selective for the major classes of groundwater contaminants: soluble organics such as benzene and trichloroethylene, inorganic cations such as lead and cadmium, and inorganic anions such as chromate and arsenate. Such a barrier would retain contaminants while allowing the groundwater to pass through.

Zeolites are naturally occurring minerals which are widely distributed in near-surface deposits in the western U.S. and other parts of the world. Raw zeolite has a high adsorptive capacity for positively charged contaminants such as lead and ammonium--in fact, cat litter is currently the largest market for raw zeolite. By treating the zeolite with cationic surfactants like those found in hair conditioner and mouth wash, the zeolite gains the ability to adsorb organics and negatively-charged inorganic contaminants, while retaining most of its ability to adsorb positively-charged inorganics. The surface-altered zeolite thus can adsorb all the major classes of groundwater contaminants.




**SMZ in a permeable barrier installation.**

Although fundamental zeolite particles are in the sub-micron range, they occur in massive deposits of stable aggregates which can be ground and sized to any distribution. Thus the hydraulic properties of the zeolite can be tailored as desired. This makes surface-altered zeolites ideal for applications such as permeable barriers, packed-bed reactors, and other flow-through systems.

## Benefits:

- Low cost alternative compared to pump and treat
- Passive system that requires no mechanical equipment, energy source, and limited maintenance following installation
- Surface-altered zeolites display a selectivity for the major classes of groundwater contaminants
- Zeolites are widely available and low cost

- The surface modification is straightforward and results in a material which is cost-competitive ($300-$500 per ton)

- Existing slurry-wall technology can be used for installation of permeable zeolite barriers

- Other treatment technologies (e.g. bioremediation, air stripping) can be focused within the barrier rather than on the entire contaminated aquifer

## Status and Accomplishments:

Phase I, was completed in September of 1996. In this phase the contractor characterized the stability of SMZ as well as its properties with respect to sorption and transport of target groundwater contaminants.

During Phase II, pilot-scale tests were performed with a permeable barrier system using engineering criteria relevant to field-scale problems and a standard protocol for testing barrier technology was developed. Since the work to be performed in Phase III was more of a pilot scale demonstration instead of a full scale demonstration, Phase II was extended to incorporate the planned Phase III efforts. This will include improvements in the pellet production process as well as the zeolite preparation and barrier emplacement processes. The work will culminate with a small scale field demonstration at the Oregon Graduate Institute using a proprietary zeolite-iron pellet mixture.

The field test under phase IIb and analysis has been completed. The pellet production run was errantly made with 1/2 the specified surfactant, but this was discovered too late in the production run to rectify. The resulting pellets still captured chromium effectively, but the TCE was shown to break through the permeable barrier after a short time.

**Photograph of the filling of the pilot-test tank.**

The results indicate that SMZ pellets show considerable promise for permeable barrier applications, but that additional development work, particularly on large scale production, is required.

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## Online Resources:

Office of Science and Technology, Technology Management System (TMS), Tech ID # 304
http://ost.em.doe.gov/tms

The National Energy Technology Laboratory Internet address is http://www.netl.doe.gov

Additional information on this technology may be found on New Mexico Tech's website located at http://www.ees.nmt.edu/Hydro/faculty/Bowman/Research